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SCAT PACKAGING PROJECT INVESTIGATION OF MEANS FOR
TRANSPORTING A SUBMERSIBLE(U) NAVAL OCEAN SYSTEMS CENTER
SAN DIEGO CA T L WEBBER 24 MAY 83 NOSC/ID-596

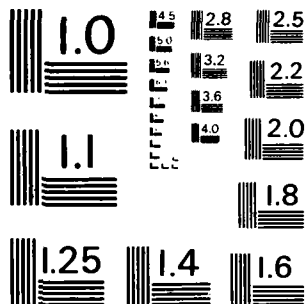
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Technical Document 596

SCAT PACKAGING PROJECT

Investigation of means for transporting
a submersible remotely controlled
tethered vehicle and its components
via commercial air freight

TL Webber

24 May 1983

Period of work: November 1982–February 1983

Approved for public release; distribution unlimited

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A N A C T I V I T Y O F T H E N A V A L M A T E R I A L C O M M A N D

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ADMINISTRATIVE INFORMATION

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AJ Schlosser, Head
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Under authority of
IP Lemaire, Head
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CONVERSION TO SI METRIC

<u>To convert from</u>	<u>to</u>	<u>Multiply by</u>
inches	mm	25.4
feet	m	$\sim 3.05 \times 10^{-1}$
cubic feet	m ³	$\sim 2.83 \times 10^{-2}$
horsepower (hp)	W	$\sim 7.46 \times 10^2$
pounds	kg	$\sim 4.54 \times 10^{-1}$
temperature, °F	°C	5/9 after subtracting 32

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This technical document explains the results of an investigation into the commercial air transportation of the Submersible Cable-Actuated Teleoperator (SCAT). The study concludes that four LD-11 containers will be needed to transport the vehicle and its necessary components to operation sites. A packaging plan is presented which uses these containers for air transportation on DC-10, L1011, and 747 aircraft. The document also presents deployment plans for both commercial air and overland transportation of the system.		

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A

BACKGROUND

The Submersible Cable-Actuated Teleoperator (SCAT) is a compact, remotely controlled tethered vehicle originally designed as a platform for conducting underwater video experiments. Code 94 management directed that the system components be reworked to fill the role of a multicapacity remote inspection/work system small enough to take advantage of the flexibility and cost effectiveness of commercial air transportation.

It was desired to equip the vehicle for undersea inspection, documentation, surveillance, implantment, and recovery at operating depths to 3000 feet. To provide these capabilities required essentially the design of a new vehicle, but it was to utilize the old parts where feasible. The new vehicle is currently equipped with one vertical, one lateral, and two horizontal thrusters with proportional controls. It has stereo TV cameras with pan and tilt control, as well as a 35-mm camera, with separate lighting sources. It is also equipped with a depth sensor, an altitude sensor, a compass, water leak detectors, power loss circuitry, and a hydrophone. It is powered by a 5-hp electrically driven hydraulic pump. The present depth limitation of 2000 feet is due to the availability of only 2100 feet of cable. A cable 4000 feet long with a larger conductor capacity would enable the vehicle to reach the full depth with satisfactory operational characteristics.

Work on SCAT has been progressing on a time-available basis. R Patterson, of the Applied Technology Division (code 942), is currently responsible for overseeing the progress of the project. The goal is to raise the system to a level of capability that will permit reliable operations in support of various projects.

PURPOSE

The purpose of the SCAT packaging study was to investigate the possibility of commercial air transportation of the SCAT vehicle and the associated

components necessary for system operation. This mode of transportation is desirable because it is more flexible and cost effective than special-airlift-mission (SAM) military air transport.

RESEARCH AND INVESTIGATION

SCAT SYSTEM COMPONENTS

To determine the limitations of commercial air transportation of the SCAT vehicle and its components requires knowledge of SCAT system dimensions and weights. The components needed for on-site operation of the system are as follows:

- Vehicle
- Flotation
- Control console
- Sonar display (two)
- Stereo TV display
- Switch and relay box
- Variable transformers
- Cable
- Generator
- Air conditioner
- Spare parts and tools

The approximate weights and dimensions of these components were measured and recorded. Components were modeled as rectangular volumes by means of the Computer-Aided Engineering and Documentation System (CAEDOS) recently installed at NOSC. This system aided in the quick and convenient development of the component models and in the subsequent creation of the outline drawings contained in this note. Sizes and weights of the individual components are shown in appendix A.

The vehicle (without attached flotation) was modeled as a rectangle with a length of 74 inches, a width of 39 inches, and a height of 37 inches. The shape of the flotation has not been determined. The syntactic foam flotation

will be cut and shaped for weight distribution when the vehicle is completely assembled with all components mounted in their respective positions. Final packaging of the vehicle will limit the shape distribution. For the purpose of this report the flotation was modeled as a rectangle 36 inches long, 24 inches wide, and 24 inches high. These dimensions were chosen simply because they represent a volume equivalent to that needed to pack the currently unshaped 24-inch by 12-inch by 6-inch flotation blocks now available.

The control console was modeled as a rectangle 30 inches long, 29 inches wide, and 50 inches high, with a lap board 11 inches deep, 29 inches wide, and 5 inches thick mounted on the front. This control console is not packaged for good space utilization. It could be redesigned to make more effective use of volume; a retractable tray design, for example, could be incorporated. Nevertheless, the dimensions of the present console were used for this study, since that is what is now available.

The model used for the needed cable volume is a rectangle 80 inches long, 34 inches high, and 47 inches wide. These dimensions represent a volume of 74 cubic feet, equivalent to that which the cable currently occupies. The packaging design allows room for expansion of this volume, if necessary, without much trouble. (The total length available now is only 2100 feet, which must be extended to attain the desired operating depth of 3000 feet.) The present cable, an assembly of three separate cables and a strength member, meets the basic conductor needs for vehicle operation. It consists of two 11/16-inch diameter cables, one 3/8-inch diameter cable, and, for the strength member, a 1/2-inch diameter double-braided nylon line. The approximate weight of this setup is 1-1/4 pounds per foot, for a total weight of 2625 pounds. (2700 pounds was used for design.) In the future this assembly should be replaced with a single cable of the necessary length that would both satisfy all of the current needs and supply additional conductors for future system expansion. The replacement cable would be about 7/8 to 1 inch in diameter. Since this new cable has not been obtained, a cable volume was used in the packaging plan that accounts for the present needs but is flexible enough to accommodate future changes.

The spare parts and tools requiring transportation to the operation site have not been clearly defined but will be established as the vehicle becomes

operational. For this packaging study, a volume approximation of 372 cubic feet was used, with no particular dimensional limitations. The overall weight requirement used was 5000 pounds.

The sizes and weights of the other system components are fairly well defined and given in appendix A.

DESIGN LIMITATIONS

To look at the limitations involved in commercial air transportation of SCAT required an investigation into the following:

- Possible destinations to which the system might be shipped
- Aircraft type
- Cargo space
- Container accommodation
- Container acquisition
- Trucking connections
- Hazardous material handling

DESTINATION

The destinations to which the system might possibly be shipped are locations near seaports. The following large cities located along various seacoasts were chosen on the basis of previous experiences with other NOSC operating systems of a similar nature:

- Norfolk, Virginia
- Miami, Florida
- Seattle, Washington
- San Francisco, California
- Honolulu, Hawaii
- Anchorage, Alaska
- New Orleans, Louisiana
- Washington, D.C.
- Portland, Oregon

Orlando, Florida
Baltimore, Maryland
London, England
Aberdeen, Scotland

AIRCRAFT TYPE

The Official Airline Guides (OAG) Air Cargo Guide, November 1982 issue (ref 1), was used to determine the flights to these locations and the types of aircraft making the flights. It revealed that the aircraft flying into these destinations were mainly the following:

- A. McDonnell Douglas DC10 (all series)
- B. McDonnell Douglas DC8 freighter
- C. McDonnell Douglas DC9 freighter
- D. Lockheed L1011 (all series)
- E. Boeing 727-200
- F. Boeing 747-100F/200C/200F freighter
- G. Boeing 747 passenger jet (all series)

Table 1 is a summary of the types of aircraft that served the various destinations.

Table 1 shows that all of the cities except Norfolk are served by the DC10 and/or the L1011. Norfolk, in contrast, is not served by any of the seven aircraft types. To get SCAT there requires trucking it from Washington, D.C. The DC10, L1011, and 747 aircraft, referred to in the airline industry as wide-bodied planes, are capable of handling air cargo of SCAT operating system size and weight. Fortunately, all the specified destinations except Norfolk are serviced by them.

1. Air Cargo Guide, in Official Airline Guides, vol 26 no 11, November 1982.

Destination	Aircraft						
	A	B	C	D	E	F	G
Norfolk							
Miami	LA	LA		LA	LA		LA
Seattle	SD/LA		LA	LA	SD/LA		
San Francisco	LA	LA	LA	LA	SD/LA	LA	LA
Honolulu	SD/LA	LA				LA	LA
Anchorage	LA					LA	
New Orleans		LA		LA	SD/LA		
Washington, D.C.	SD/LA			LA	SD/LA		
Portland	LA		LA		SD/LA		
Orlando				SD/LA	LA	LA	
Baltimore	LA	LA					
London	SD/LA	LA	LA	LA	LA	LA	LA
Aberdeen	LA					NY	NY

LA = service from Los Angeles
SD = service from San Diego
NY = service from New York

Table 1. Types of aircraft that served 13 seacoast cities in 1982.

CARGO SPACE

The wide-bodied planes are available as freighter models, for all-cargo flights, or as passenger/cargo models, for a combination of passenger and cargo service. For freight-only flights, the cargo occupies the entire internal volume of the plane. For the combination flights, cargo is carried in the belly compartments, passengers in the upper levels. Although bulk packages are handled on both types of flights, the larger ones go on the freighter

flights. It is preferred to have a flexible packaging plan so that the system can be accommodated on either type of flight. It is also desirable to have the SCAT crew on the same flight as the equipment; hence the packaging scheme should allow transport on passenger/cargo flights as well as on all-freight flights.

Each type of aircraft has its own size and weight limitations of bulk packages it can carry. These depend upon the door sizes and structural design of the particular plane. Charts are available that give the limitations on bulk shipping for the various aircraft (ref 2). However, each item of cargo over 500 pounds to be shipped on a plane also carrying passengers must be secured in one of a series of special containers certified by the FAA. The containers have the proper dimensions to fit into the cargo holds of the planes. They have the strength to assure restraint of the cargo under various circumstances. Furthermore, each container serves as a structural support member for the plane when it is locked in place ready for flight. Since the SCAT system components are over the 500-pound weight limit, they must be shipped in these special containers.

CONTAINER ACCOMMODATION

The next step was to investigate which containers fit which planes. This was done by using the Supplement to Air Cargo Guide (ref 2) and by contacting various airline freight offices and a container manufacturer. These contacts are given as appendix B. The containers are standardized; some containers fit numerous types of aircraft. Figure 1 is a summary chart. The M-1 and LD-11 containers meet our requirements: they fit the aircraft that go to the desired destinations (DC10, L1011, and 747), and they are of the size required to move the SCAT system.

Notice that LD-11 and LD-5 refer to the same container. In the past these were two separate containers with slight differences. The standards have been changed so that the containers are now essentially the same, with similar dimensions and aircraft compatibilities. It was found that many

2. Supplement to Air Cargo Guide, in Official Airline Guides, December 1982.

Air Freight Containers

(Dimensions and weights are approximate and may vary slightly between airlines)

Type	Owner	Corresponding IATA Container Classification		Cubic Capacity	External Dimensions and Cubic Displ	Weight		Handling Features for Shippers
						Minimum Chargeable Pounds	Maximum Gross Weight	
M-1	Airline provided available at 1470 cu ft	Typical		472 cu ft	L 125 W 96 H 96 cu disp: 866 cu ft	4,400	15,000	Picked up, delivered on conventional truck trailer chassis
M-2	Airline provided available at 1470 cu ft	Typical		1,100 cu ft	L 240 W 96 H 96 cu disp: 1,280 cu ft	12,363	25,000	Picked up, delivered on conventional truck trailer chassis
L-6	Airline provided			370 cu ft	L 160 W 60.4 H 64	2,800	7,000	Direct Transports Available
LD-7	Airline provided available at 440 cu ft	Typical		cu capacity 355 cu ft	L 125 W 86.3 H 63 cu disp: 401 cu ft	2,800	10,400	Direct Transports Available
LD-11 LD-5	Airline provided available at 440 cu ft	Typical		cu capacity 370 cu ft	L 125 W 86.4 H 64 cu disp: 277 cu ft	1,800	7,000	Direct Transports Available
L-10	Airline provided	Typical		varies	L 125 W 60.4 H 63 cu disp: 242 cu ft	1,494	4,500	Direct Transports Available
A-1	Airline provided available at 1470 cu ft			cu capacity 333 cu ft	L 88 W 121 H 87 cu disp: 675 cu ft	1,000	11,500	Direct Transports Available can be Palletized
A-2 A-3	Airline provided available at 1470 cu ft			cu capacity 440 cu ft	L 88 W 125 H 87 cu disp: 675 cu ft	1,200	12,500	Direct Transports Available can be Palletized
B	Shipped provided	Insert for A		varies	L 84 W 58 H 76.4h cu disp: 197.70 cu ft	1,800	5,000	Palletizable
LW	Airline provided			varies	L 98 W 42.2 H 6 cu disp: 76 cu ft	500	1,200	Direct Transports Available
FTC	Airline provided available at 1470 cu ft	Typical		cu capacity 150 cu ft	L 81 W 60.4 H 62.75 cu disp: 174.5 cu ft	1,200	4,500	Palletizable
LD-3 LD-1	Airline provided available at 440 cu ft	Typical		cu capacity 150 cu ft	L 79.0 L 62.0 W 60.4 H 64.1 cu disp: 166.0 cu ft	1,100	3,500	Direct Transports Available
B-2	Shipped provided	Insert for A		varies	L 42 W 58 H 76.4h cu disp: 98.85 cu ft	900	2,500	Palletizable
D	Shipped provided	Insert for A		varies	L 58 W 42 H 45 cu disp: 63.44 cu ft	500	1,000	Palletizable
LD-N	Shipped provided	Insert for A		varies	L 58 W 55 H 57 cu disp: 101.6 cu ft	900	3,100	Palletizable
F	Shipped provided			varies	L 42 W 29 H 25.5 cu disp: 17.97 cu ft	130	500	Side Handles Recommended
E-H9	Shipped provided	Insert for A		cu disp: 9.03 cu ft	L 35.4 W 21 H 21	100	250	Consult Air Carrier
E-H10	Shipped provided				L 36 W 22 H 22		300	
QD	Shipped provided	None		varies	L 39.5 W 27.5 H 21 cu disp: 12.0 cu ft	100	400	Side Handles Recommended

Courtesy Air Cargo, Inc.

SUPPLEMENT TO AIR CARGO GUIDE

Figure 1. Standard air freight container chart. Reprinted by special permission from the September 1982 supplement to Official Airline Guides "Air Cargo Guide," part 2. All rights reserved. Official Airline Guides is a company of the Dun and Bradstreet Corporation.

people working in the air freight industry are not clear on the relation between the two types. In this report the container will be referred to as an LD-11.

CONTAINER SELECTION

The study then involved the selection of either the M-1 or the LD-11. Three main factors were analyzed in making a decision: volume, cost of shipment, and flexibility in usage. The M-1 is over twice as large in volume as the LD-11. Two M-1 containers or four LD-11 containers would be required to move the SCAT system. A combination of the two types could be used. After talking with various airline freight offices, however, it was learned that four LD-11 containers could be shipped for about the same cost as one M-1 container. (In December 1982, American Airlines quoted a price of \$810 for shipping an LD-11 container to the east coast versus a cost of \$3170 for an M-1.) As for flexibility, the M-1 is restricted to 747 freighter-only flights, whereas, the LD-11 can be flown on any of the wide-body flights — freight-only or passenger/cargo. Also, the LD-11 is easier to handle than the M-1 because it is smaller. Thus it was decided to base the packaging plan on the use of four LD-11 containers rather than two M-1 containers or a combination of the two types.

LD-11 CONTAINER DESCRIPTION

A standard LD-11 container is a rectangular solid 125 inches long, 60.4 inches wide, and 64 inches high. Figure 2 shows an LD-11 marketed by Trans-equip, a container manufacturer, along with its specifications. Internal dimensions and container weights vary with different manufacturers. The worst-case internal dimensions recommended by Transequip for packaging design are length 114 inches, width 55 inches, and height 56 inches (figure 3). Numerous airlines were asked to check their LD-11 internal dimensions. It was verified that these are indeed the worst-case values, most values being slightly larger, so they were used in the design of the packaging plan. Container weights vary from manufacturer to manufacturer between 500 and 650 pounds. Consequently for an allowable loaded gross weight of 7000 pounds, the worst-case allowable net cargo weight, used in the packaging plan design, is 6350

LD - 11

Netted Front

Certified
NAS 3610-2L1C
(IATA-AWB)

Aircraft Applications:

B747, DC-10, L-1011, A300B

Overall Size:

60.4" x 125" x 64"

Tare Weight:

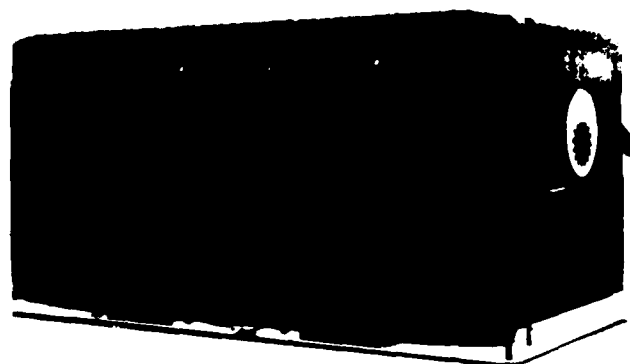
Approx. 530 lbs/240 kgs

Capacity:

Max. Gross Weight:	7000 lbs/3175 kgs
Internal Volume:	238 cu. ft./6.7 cu. m.
External Volume:	267 cu. ft./7.5 cu. m.

Construction:

Shell - Laminated reinforced fiberglass
Base - Aluminum plate or
Balsa aluminum laminate
Vinyl cover and nylon net



P/N 302756-1

Figure 2. LD-11 container. Copyright ©1977 by Transequip Inc. Reproduced with authorization of Transequip Inc.

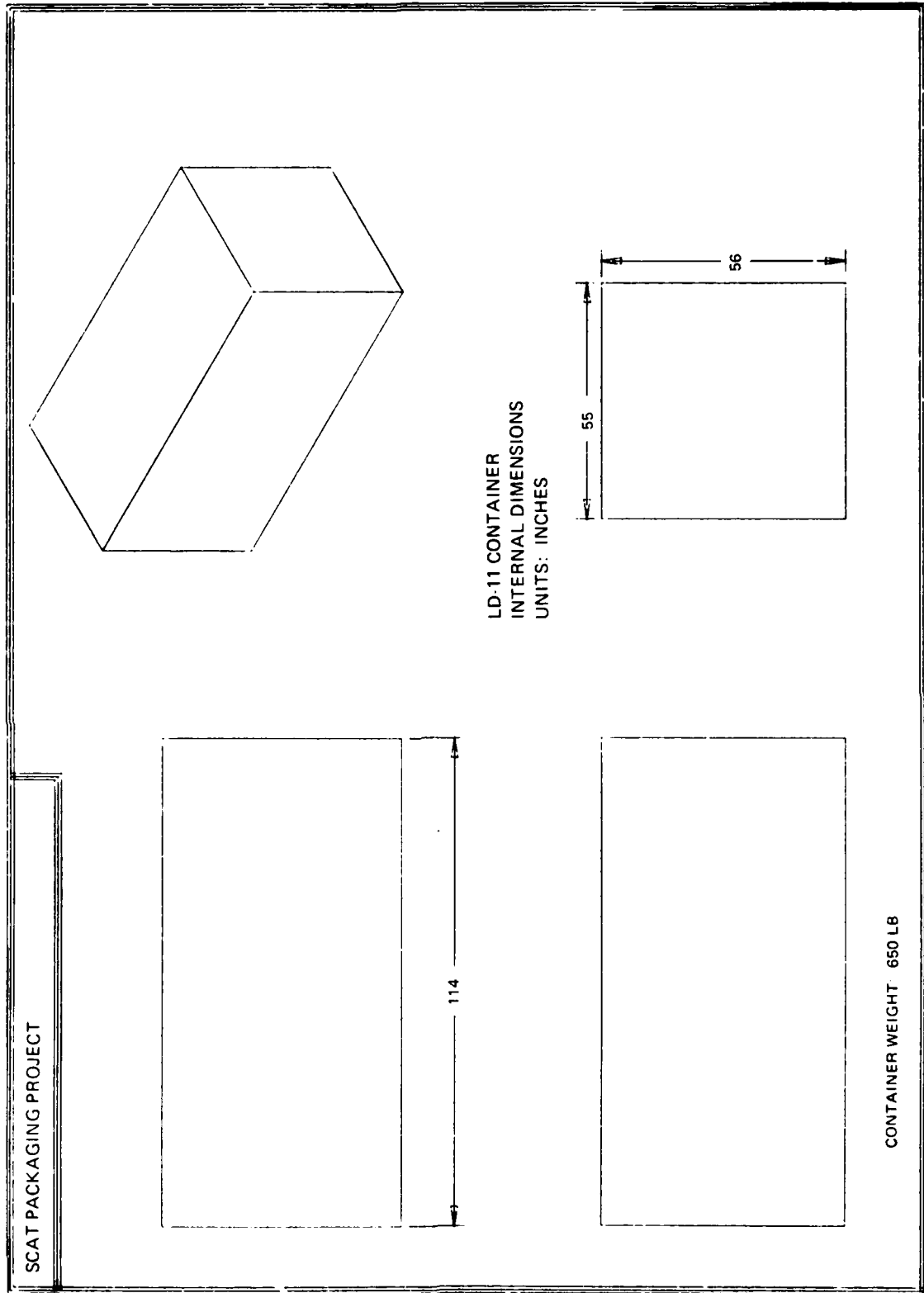


Figure 3. Worst-case internal dimensions of LD-11 container.

pounds per container. The walls of most containers are constructed of laminated reinforced fiberglass, but some are available that are made out of aluminum. The bases are constructed out of aluminum or balsa-aluminum laminate and can be obtained with or without forklift capability. The containers all have one open side for loading and unloading. The covering for this side can be either a canvas and net covering or solid doors with locking capabilities. The interior can be equipped with various tie-down fittings and shelving arrangements.

CONTAINER ACQUISITION

Three options are available for container acquisition. The first is to attempt to design and construct our own containers using in-house facilities. The second involves using the containers provided by the individual airlines for their customers. The third consists of buying containers from a container manufacturer.

In-house Manufacture

The containers used for commercial air transportation must be certified by the FAA. Uncertified containers are in use, but most of the airlines will not ship them. Therefore, it was decided that only certified containers should be used for the packaging plan. This presents the problem of getting FAA certification of a container manufactured in house. The Transequip container manufacturing firm and the FAA were consulted concerning this issue. (The contacts are given in appendix B.) Container certification requires extensive design, documentation, and inspection per FAA rules and regulations. It would require an extremely long time and great expense to produce a container in accordance with these FAA restrictions. Also, the facilities for manufacturing a certified container must be inspected and qualified by the FAA to assure that the manufacturing processes in use are acceptable. Therefore it was decided that the option of making our own containers would be both time and cost prohibitive compared to the options in which already certified containers are used.

Using Airline-Furnished Containers

The option of using certified airline-furnished containers involves two suboptions. One is to hold onto the airline's containers permanently and to use them for both transporting and storing the equipment. Standard procedure is for the airline to provide the container free of charge for a 24-hour period, as is usually required for undelayed air transportation. If the 24-hour period is exceeded, most airlines charge a fee of \$10 per each day in excess. This would result in a yearly fee of about \$3650, which is unacceptable since the price of purchasing a container is in this range. The other suboption is to construct uncertified containers of our own that can hold all the necessary equipment and that in turn fit into certified airline-provided containers. This option represents, essentially, a dual containerization. The airline's containers would not have to be held permanently; rather they would be used only for transit. The SCAT equipment would be organized and stored in the uncertified containers until the need arises for transport, then these containers would be loaded into the airline-provided certified containers for flight. This suboption consumes available volume because of the double containerizing. The use of an internal container subtracts 32% of the available LD-11 internal volume if the internal container has 3-inch walls and a 6-inch base for forkability in loading and unloading. Thus five LD-11 containers instead of four would be needed, increasing the per-deployment cost of using SCAT. Also the airlines would have to keep five LD-11 containers on hand for SCAT deployment needs. This does not present a problem for flights out of Los Angeles International Airport; but for flights out of San Diego, the airlines usually have only one LD-11 on hand. Additional containers require 24 hours' notice to the airlines, then are trucked here from Los Angeles. This presents unacceptable delay to deployment in the event that time is an important factor.

Buying Containers

The option of buying certified LD-11 containers appears to be the most efficient choice. The cost estimate for an LD-11 container from the Trans-equip container manufacturer was about \$2000 for a fiberglass-shelled container with netting for the open side cover and no additional accessories. Brownline and Perkins Co, another container manufacturer, quoted a price of

\$6000 for a container made of either fiberglass or aluminum, with a forklift-able aluminum base, locking side doors, an internal folding shelf, and inside tie-down attachments. Prices depend upon the accessories chosen, ie construction material, solid doors vs netting, and shelving or tie-down arrangements. Either price is less than the cost of retaining the airline's containers for 2 years. Owned containers would always be on hand; therefore no delays would be caused by insufficient stores at the airport. Equipment can be packed and stored as necessary for deployment, always ready for loading directly onto the aircraft. This prevents time lost in loading containers into an airline's LD-11s, as would be necessary in the dual-container concept. This option also uses fewer LD-11s, because volume is saved by avoiding the need for dual containers. As pointed out, the four LD-11s in this plan provide more volume than the five LD-11s in the dual-container concept. Since fewer containers are needed, the cost per deployment is also less than for the double containerization option. At a cost of about \$800 per container for shipment, the savings of shipping only four containers instead of five would save enough in 30 deployments to pay for four of the more expensive containers. If the less expensive containers are purchased, payoff would take only 10 deployments.

CONTAINER ACCESSORIES

Recommendations on accessories for the containers have been avoided in this note, for many reasons. For one, the spare part and tool needs are indefinite. When these are better defined, decisions can be made on shelving and tie-down needs. On the choice of material for the shell, aluminum may hold up better but fiberglass is easier to repair if damaged. The choice between solid doors and netting depends upon available funding. Solid doors are more expensive but provide better weatherproofing, whereas the use of netting requires more care in the weatherproof packaging of the individual parts. These decisions will be made when the needs and available funding are more accurately defined.

TRUCKING CONNECTIONS

The use of LD-11 containers facilitates the use of trucking as a means of overland transportation. They are not too large to be loaded conveniently

onto flatbed trailers and strapped down for transit. Trucks equipped with air suspension should be used to protect the system from shock and vibration. The containerized system will be trucked from home base to airport and from destination airport to dock and local operation sites. Forklifts are needed for loading and unloading the trucks; and a crane, with straps for the forkliftable containers, is needed at the ship. This equipment must be able to handle containers as heavy as 7000 pounds, the maximum weight per container allowed by the airlines.

HAZARDOUS MATERIAL HANDLING

A final design limitation for the packaging plan involves hazardous materials. Spare hydraulic oil is the only fluid that must be shipped with the system. Its flash point, 210°F, does not qualify it as a flammable material, but it is classified as a combustible material and must be specially packed and labeled by the NOSC Supply Department. The other necessary hazardous fluid, fuel for the generator, should be easily obtainable at the destination and need not be shipped. Generator fuel should be purged from the fuel lines and tank prior to shipping. According to the Department of Transportation, the oil can be left in the generator since it is not classified as a flammable liquid. Furthermore, a battery for the generator should be obtained at the destination to avoid various restrictions on battery shipment, which depend upon the chemical contents and vary with the destination.

PACKAGING PLAN

Each of four certified LD-11 containers will be packed in a specific arrangement of particular pieces of equipment. The four LD-11s will be referred to as follows:

LD-11A

LD-11B

LD-11C

Control room

The first three are standard LD-11 containers with certain equipment assigned to be packed directly into them. The fourth employs dual containerization, in which the internal container is a "pop top" control room that when collapsed fits into a standard certified LD-11 container. Each container and its assigned packing configuration is discussed in this section.

LD-11A

The main components to be packed in LD-11A are the vehicle and the flotation. The volume not otherwise occupied will be used for packing spare parts and tools. Figure 4 shows the packing configuration. The vehicle is loaded into the corner of the container closest to the access opening. A space of 3 inches is left beneath the vehicle to provide room for mounting it on vibration and shock isolators. This was decided to be adequate on review of isolator manufacturers' catalogs. Figure 4 models the flotation as a rectangle of 24-inch width, 24-inch height and 36-inch length. These dimensions were chosen simply because they represent a volume for packing the flotation components in their present shape - numerous 24-inch by 18-inch by 6-inch blocks. After the vehicle is assembled in its final operating configuration, the flotation will have to be shaped and mounted so as to provide the proper distribution of buoyancy. Final shaping of the buoyancy must take into consideration the configuration of this packaging plan. With 3 inches left beneath the vehicle for vibration isolators, there is a clearance of 16 inches above the vehicle for the worst-case dimensions of an LD-11 container. Shaping the flotation so that it occupies a height of 14 inches will allow a 2-inch clearance for moving the vehicle into and out of the side-loading container.

The flotation could be designed to allow its removal for transportation. It could be cut into numerous sections that could be removed from the top of the vehicle before the LD-11s are packed. This would allow flotation height greater than 14 inches if necessary. The sections should be dimensioned so that they can be packed around the vehicle in LD-11A. An alternative would be to pack the removable flotation sections in LD-11C (which contains spare parts and tools), some contents of which could be moved into LD-11A around the vehicle. This would be necessary only if the sections could not provide the necessary buoyancy distribution if cut so as to fit around the vehicle.

SCAT PACKAGING PROJECT

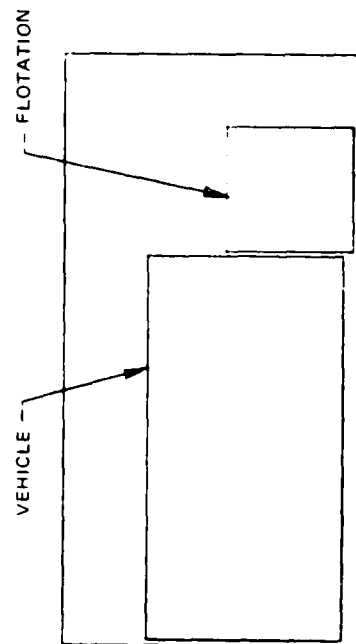
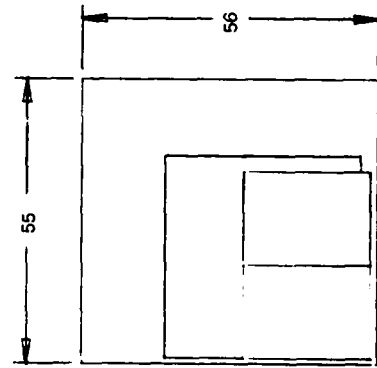
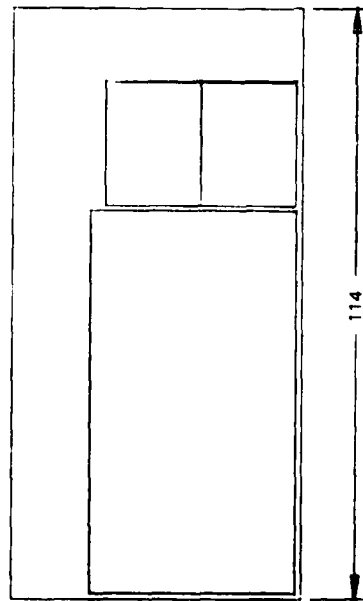
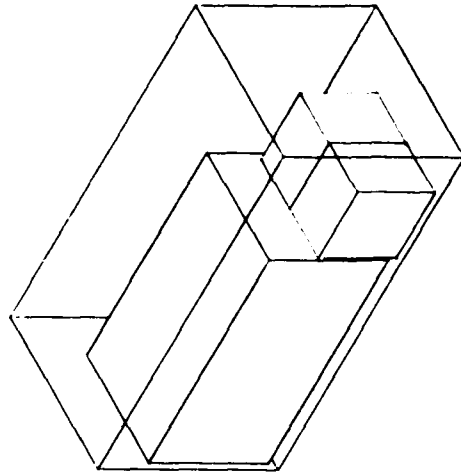


Figure 4. LD-11A packing configuration.

The rest of the volume in LD-11A not occupied by the vehicle and its flotation, about 129.4 cubic feet, can be packed with up to 4775 pounds of spare parts and tools arranged to allow easy access and removal of the vehicle and its flotation. The 4775-lb figure is an approximate value obtained by subtracting from the allowable gross weight of 7000 pounds per LD-11 container the weights 650, 1250, and 325 pounds for the container, vehicle, and flotation, respectively. The definite allowable weight for spare parts and tools in this container depends upon the weights of the vehicle and flotation when they are finally assembled and shaped. It also depends upon the weight of the particular LD-11 container, as determined by its make and the accessories chosen for it. The container weight of 650 pounds was the highest encountered from data supplied by several airline freight offices. Definite values for the weights can be set as the system draws nearer to final assembly. The vehicle probably will be removed from the container on the docks, where handling equipment is available, then hoisted onto the ship and put into position by means of the ship's crane. Any removable flotation that had been stowed for transit can be mounted on the vehicle for operational use either on the docks or on the ship. After the vehicle and flotation are removed from the container, the latter can be hoisted on board the ship and positioned as necessary, to serve as a storage area for spare parts that it holds.

LD-11B

The main components to be packed in LD-11B are the generator and the cable. The volume not occupied by these parts is used for packing more spare parts and tools. Figure 5 shows the packing configuration. The generator is packed in one end of the container, with the cable box occupying the rest of the length. The generator should have the fuel drained for shipment because of hazardous materials limitations. Since these products should be readily available at any destination, a procedure that avoids possible confusion over regulations is to ship the generator drained, then to obtain fuel and oil at the destination site.

The cable box was modeled to occupy the volume that the present cable requires. As stated earlier, there will be changes in the future cable requirements — either more sections of the same type of cable to increase the

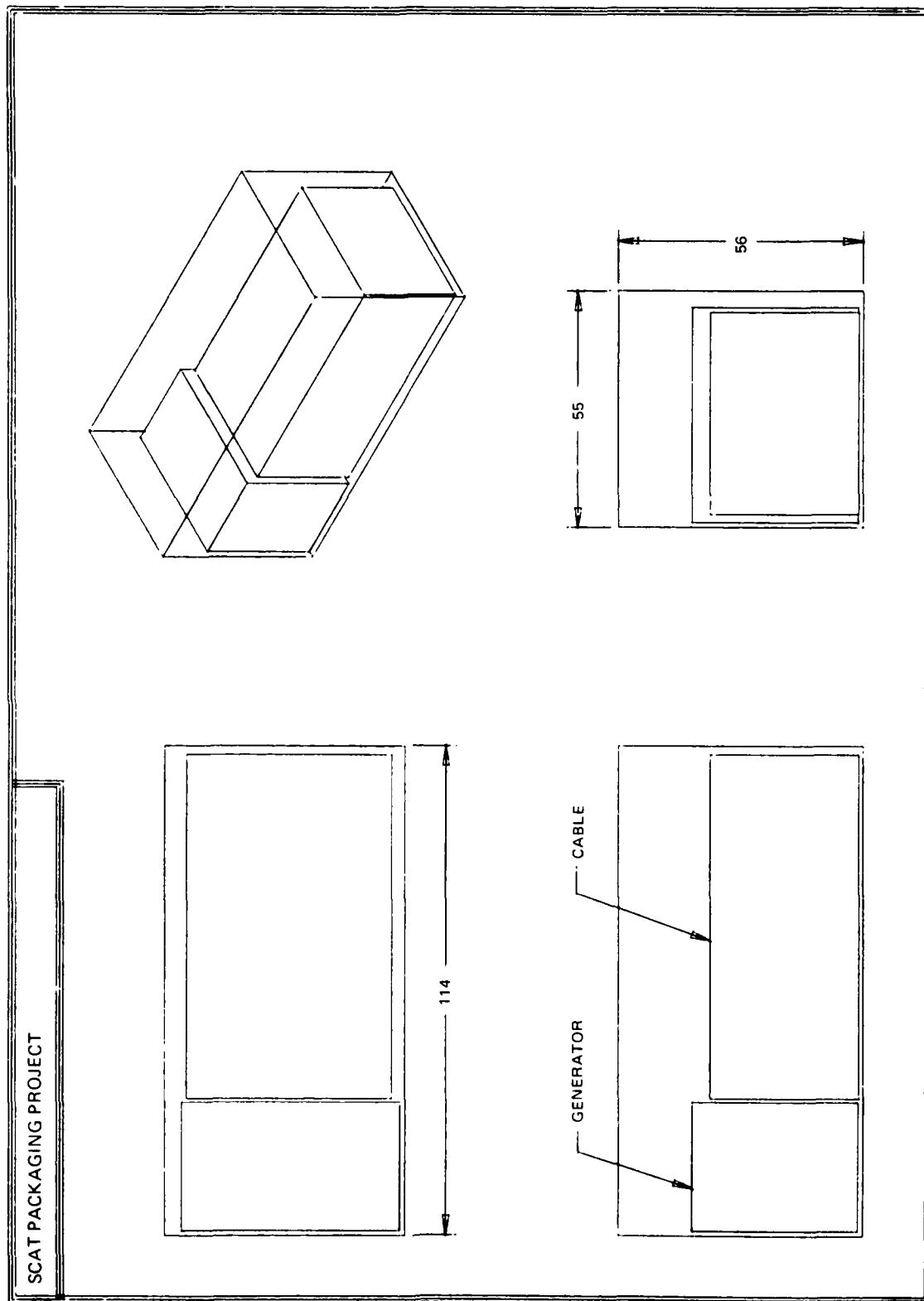


Figure 5. LD-11B packing configuration.

available length or a single replacement cable of the necessary 4000-foot length. Since these possibilities represent different volume needs in the packaging plan, the packing of LD-11B was left flexible enough to accommodate changes.

The model used for these studies, shown in appendix A, is a rectangular solid 80 inches long, 47 inches wide, and 34 inches high. This volume accounts for the requirements of the present cable assembly. It allows for 3-inch walls in the construction of a basket to hold the cable. Allowing 2-inch clearance in height for loading and unloading leaves 20 inches of height available for expansion of the cable basket, to accommodate more volume of cable if necessary. The cable basket could also be expanded another 6 inches in width if needed, while still leaving 2 inches for handling clearance. These possible expansions represent an additional 58.5-cubic-foot available increase in cable volume over the present requirement of 74 cubic feet. Thus the maximum available volume for the cable and its basket is 132.5 cubic feet.

Whatever space is left over in LD-11B, about 96 cubic feet if the current cable volume is used, is packed with spare parts and tools. The allowable weight for spare parts and tools under these conditions is 2450 pounds on the basis of a maximum of 7000 pounds for the allowable gross weight per LD-11 container. Again, these are approximate values that depend upon the actual volumes and weights of the LD-11 container obtained and the weight of the final cable and basket setup. More definite values will be established as the equipment is obtained and measured.

The plan for handling the equipment in LD-11B calls for the cable basket to be unloaded on the docks, where handling equipment is available, then to load the basket onto the ship and put it into place by means of the ship's crane. Unloading the cable basket could also be done on board ship if the necessary equipment is available. LD-11B, with the generator and spare parts still inside, would then be loaded onto the ship. It might be desirable to shift the generator to the center of the container to balance the weight distribution before hoisting. The LD-11B will serve as an onboard shelter in which to operate the generator. For this reason, any spare parts and tools

left inside this container should be insensitive to the vibrations of generator operation. There is enough room to mount the generator on vibration isolators. When the generator is in operation, the doors of the container should be left partially open to allow for exhaust ventilation.

LD-11C

LD-11C is set aside for carrying spare parts and tools, as shown in figure 6. Its total volume of about 203 cubic feet is intended for any spare parts and tools that must be transported to the operation site. Although the spare part and tool requirements are not very well defined at this time, the volume needs for this study were taken to be about 372 cubic feet, with a weight of roughly 5000 pounds. Between this container and the extra space in LD-11A and LD-11B, a total volume of about 428 cubic feet and a total allowable weight of about 13 575 pounds are available for spare parts and tools. Table 2 shows the recommended distribution.

Container	Volume (cu ft)	Weight (lbs)
LD-11A	129	4 775
LD-11B	96	2 450
LD-11C	203	6 350
Total	428	13 575

Table 2. Recommended volume and weight distribution among LD-11A, LD-11B, and LD-11C.

The containers can be obtained with a variety of shelving and tie-down arrangements to accommodate the variously sized parts. The larger items are packed in LD-11C, while the smaller ones are packed around the components in LD-11A and LD-11B. The packing configuration of the spare parts and tools is left open until a clear definition of the needs is established. After that, a packing configuration can be designed for convenience and accessibility. Once on site, LD-11C should be loaded directly onto the ship, where it will serve as storage for the spare parts and tools.

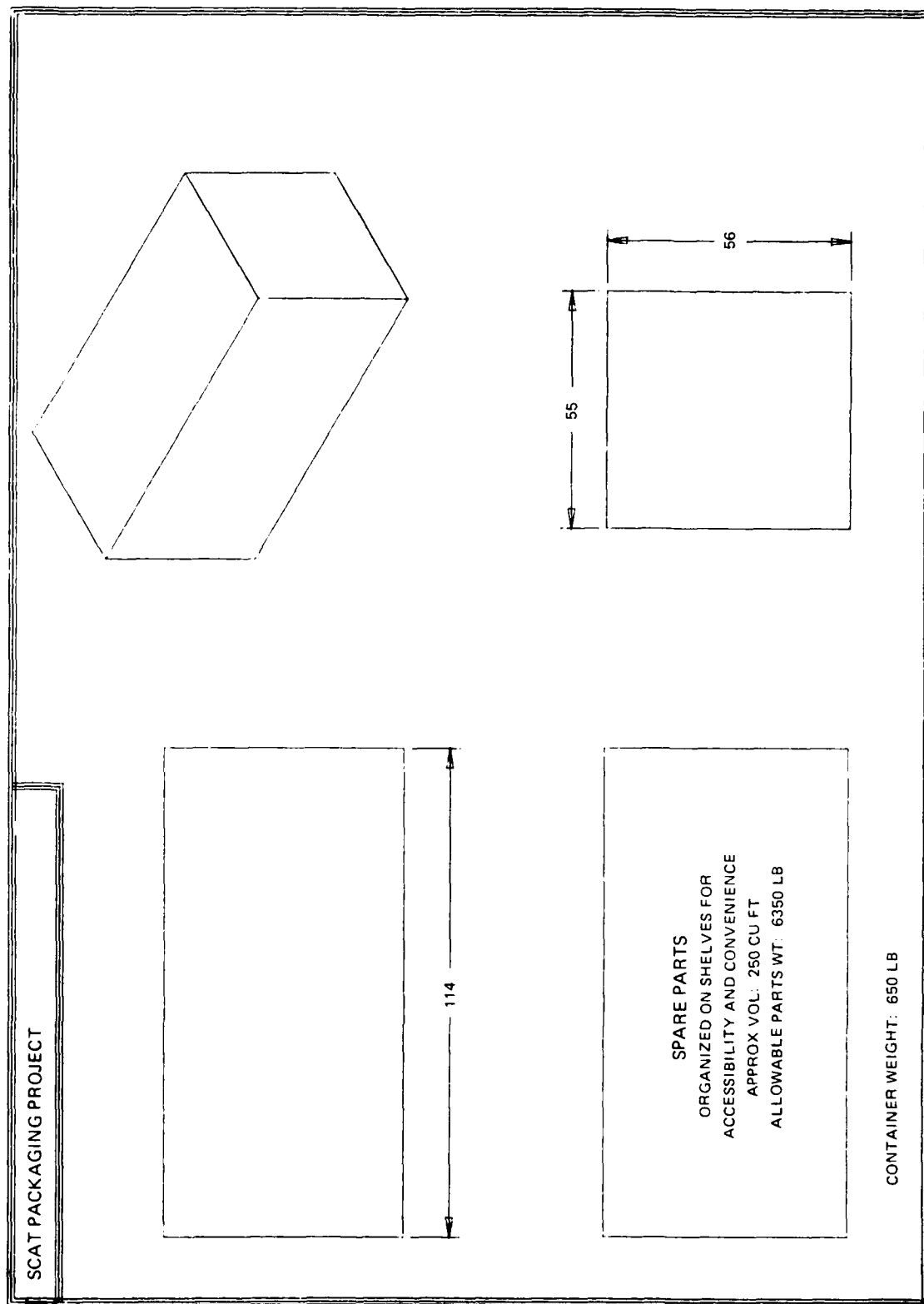


Figure 6. LD-11C container, for spare parts.

CONTROL ROOM

The dimensions of the standard LD-11 container (fig 2) obviously limit its applicability as a control room in which operators can work and move around. Three possible solutions were investigated. The first involved using a standard LD-11 equipped so that the men could operate the vehicle in a sitting position without standing up. This option was ruled out because of the severely tight quarters and possible claustrophobic reactions of the operators. The other two options involved the so-called pop-top control room.

The control room container (fig 7) is vertically expandable, like a pop-top recreational vehicle camper. It consists of upper and lower sliding halves that form an adjustable volume. It operates in either the transit mode, in which the upper section is collapsed on the lower to form the smaller volume for transportation, or the operating mode, in which the upper half is raised to provide standing room. Initially, it was thought that a standard LD-11 container could be modified or constructed with pop-top capability. But consultation with a container manufacturer disclosed that a modification of this extent would require essentially the design, documentation, and certification by the FAA of a new container, at a cost prohibitive for the production of a single unit.

Dual containerization, on the other hand, provides a certified, expandable, and less costly solution: a control room built with a pop-top is dimensioned to fit within a certified LD-11 container. Since the internal container itself does not have to be certified, the expense of a new container is saved. The dimensions shown in figure 3 are those required for an internal container that will fit into the worst-case inside dimensions of an LD-11 container. A wall thickness of 3 inches is allowed for each of the side walls on both halves and for the roof of the top half. A floor thickness of 6 inches is allowed for the bottom, to make room for a forklift capability. An extra 2 inches is left on one side to allow room for door hinges. With a door incorporated into a design using these allowances, the inside dimensions of the collapsed internal container become 102 inches in length, 41 inches in width, and 47 inches in height (fig 8).

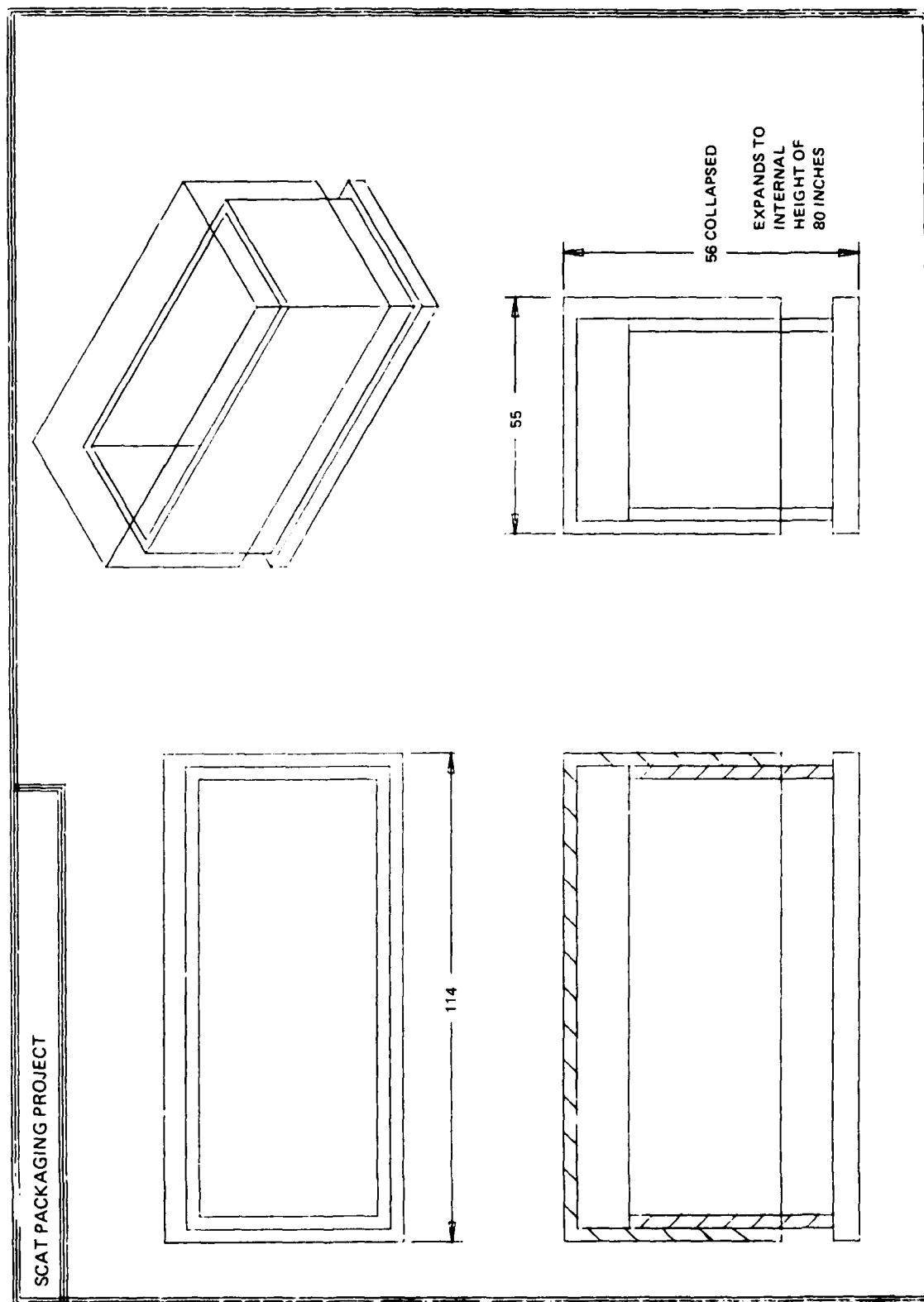


Figure 7. Expanding control room concept.

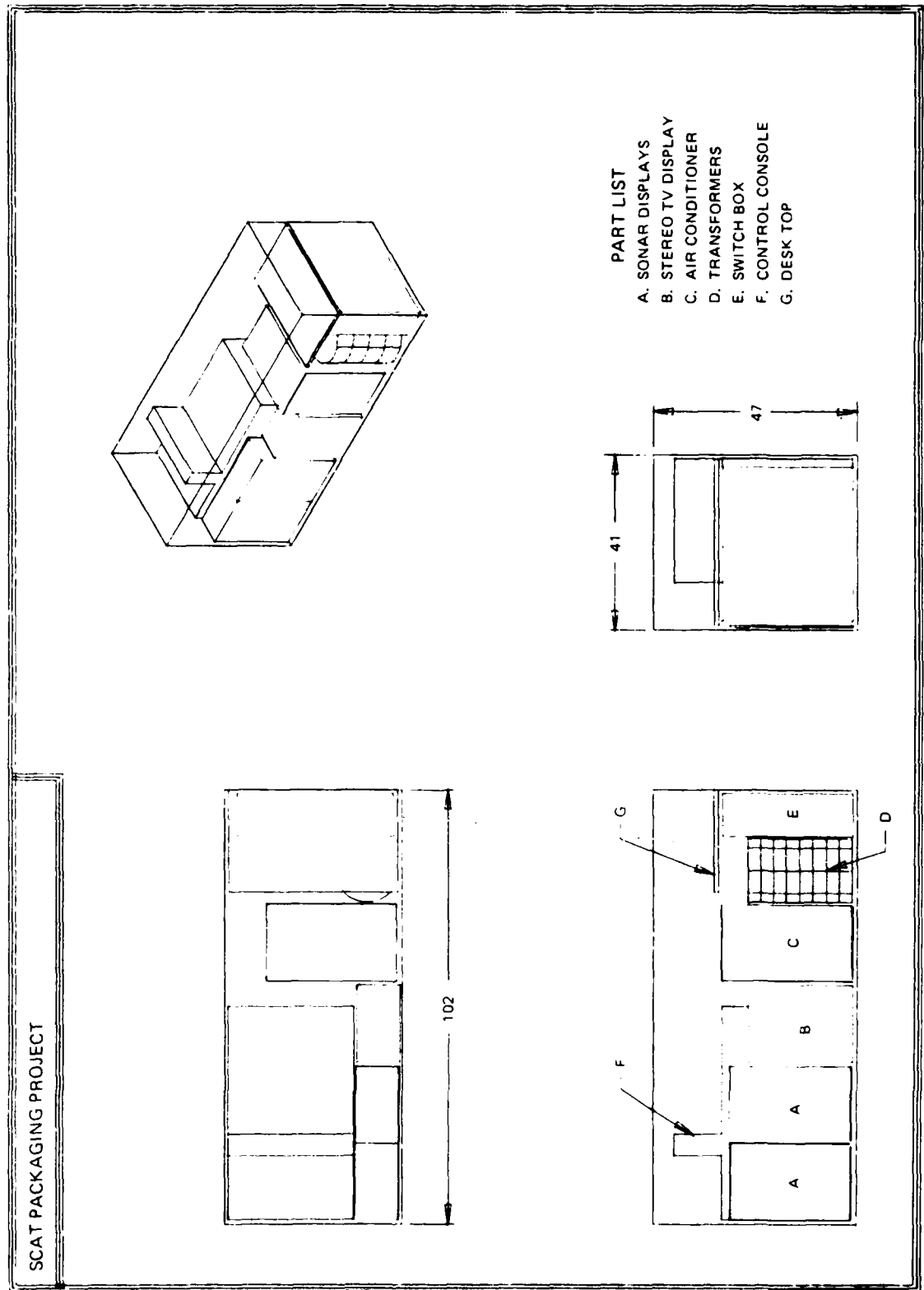


Figure 8. Control room packing concept, showing inside dimensions of the collapsed internal container.

Figure 8 shows the collapsed pop-top control room internal space with the necessary control room equipment, as listed, packed into it. Not shown are two folding chairs and a lamp fixture for an inside light source. The packing configuration shown uses the dimensions of all the components in their present forms and allows 1/2 to 1 inch of clearance between each surface. Some of the equipment, such as the control console, could be redesigned to be more space efficient. Any redesign would alter the packing arrangement shown. Fitting the present equipment within the container requires that the control console be laid on its back with the other equipment packed around it.

Figure 9 shows the internal pop-top control room container expanded with the equipment arranged in its operational configuration. The internal height is 80 inches, allowing standing room. One of the two sonar displays is mounted on top of the control console. The second sonar display, along with the stereo TV display, is mounted at the other end of the control room at a level appropriate for a seated operator. The desk top is provided as a workspace for this second operator. A second stereo TV display could be mounted on top of the control console if it is necessary to provide similar sources of information to the two operators. The operators sit back to back in folding chairs that are offset to provide each other as much room as possible. The air conditioner is of the outside-mounted window type. Once on site, it is unloaded and mounted on the exterior of the container, its output flowing through a ventilation hole let through the side.

The control room is rearranged and collapsed to be shipped within a certified LD-11. Loading of the internal container into the LD-11 is done at either the home base or the departure airport, depending upon whether a fourth LD-11 is owned or an airline-supplied container is used. After the flight, it is unloaded from the LD-11 at either the destination airport or the berth of the waiting ship. The certified LD-11 is needed only for the air transportation phase. Once the control room is removed from the LD-11, it can be fork-lifted, trucked, and sling-lifted by crane onto the ship. Once the control room is emplaced, its top half is raised and the interior equipment is rearranged for operational use. The control room must be weatherproof whether collapsed or expanded, since it will be exposed to the outside environment whenever it is not stowed within the LD-11.

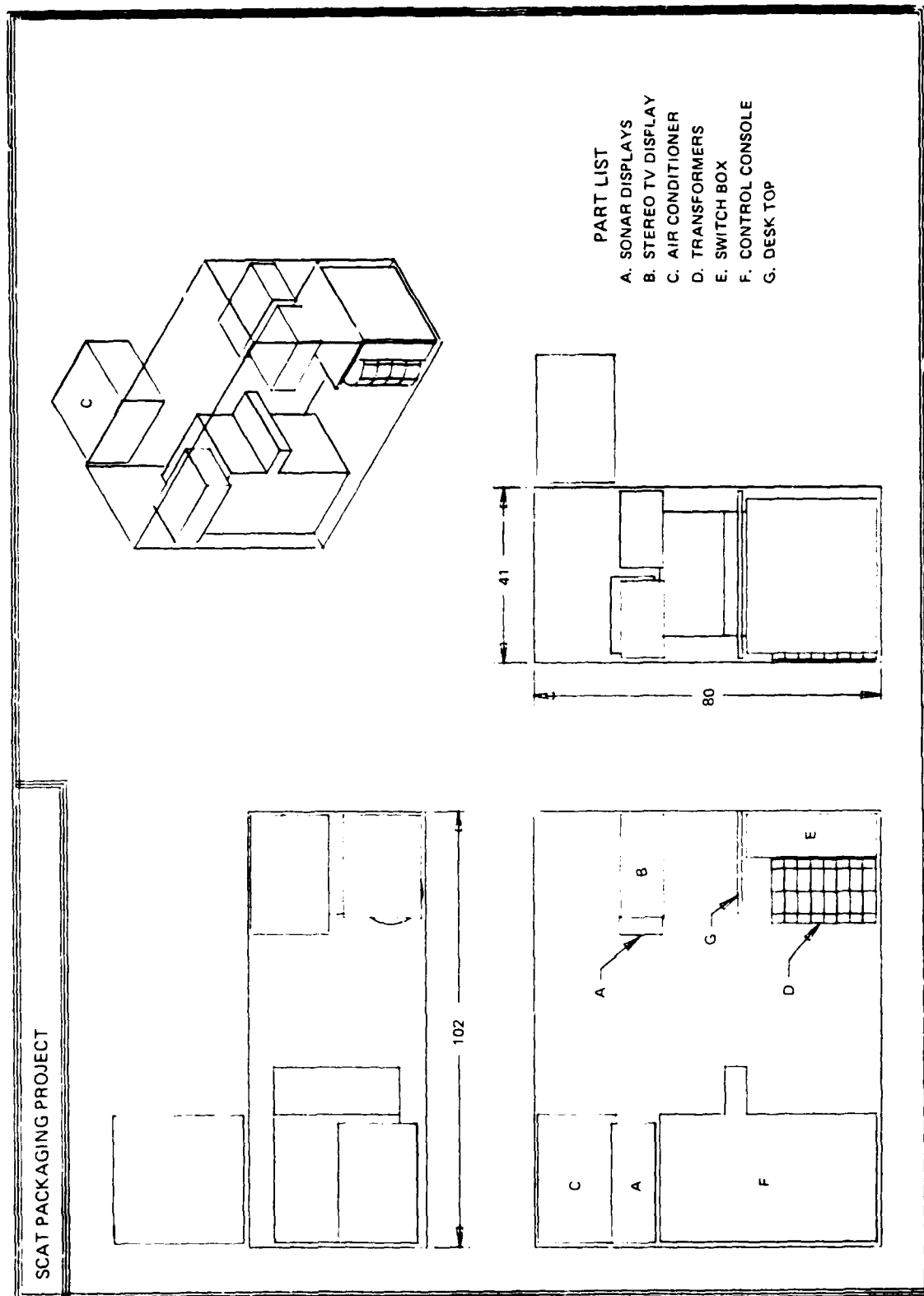


Figure 9. Expanded control room.

The control room is the only part of the SCAT system that does not require having an LD-11 on hand. The rest of the system, consisting of numerous pieces of equipment, is loaded and stored directly in the government-owned LD-11s, which serve as their permanent containers and weather shelters. The internal pop-top container serves those purposes for the control room equipment. It must be easy to load into and unload from a standard LD-11, as a unit. Since the LD-11 container housing it is necessary only for the air transportation phase and at no other time, a fourth LD-11 does not necessarily need to be purchased with this packaging plan; the use of a certified LD-11 provided by the airlines might be satisfactory. The advantage of owning the fourth container lies in having it always on hand, thereby avoiding possible delays in obtaining an airline's LD-11 and loading the control room into it. This advantage would be important in situations where time is of great importance, as in emergency operations.

DEPLOYMENT PLAN

Deployment of SCAT when a call for it is received involves the planning, decisions, arrangements, and contacts needed to move the SCAT system from NOSC to an operation site. This discussion assumes employment of the recommended packaging plan.

The basic deployment plan was modeled after the CURV III deployment plans (ref 3), with only minor changes. Figure 10 is a flowchart for the deployment of the SCAT system.

When a call is received that requests the system for an operation, the following information must be obtained:

- Destination point
- Nature of job
- Time frame
- Special requirements
- Situation report

3. NUC TN 1220, CURV III Deployment Plan, by RL Watts and LK Brady, March 1974.

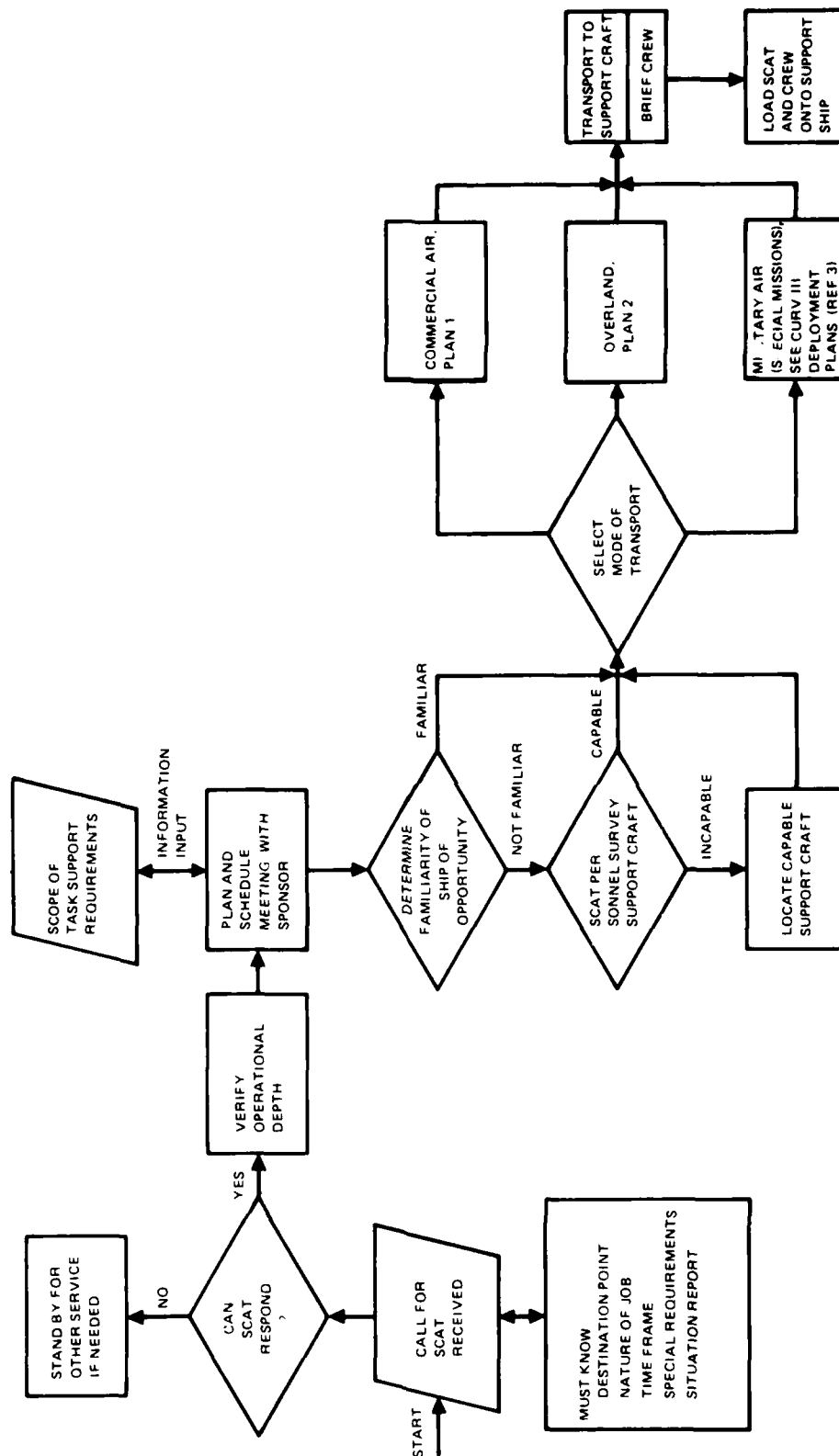


Figure 10. Deployment plan flowchart.

This information is used to decide whether or not SCAT can respond to the request. Inability to respond is relayed to the requestor, then the system is placed on standby pending other requests.

If SCAT can respond, its ability to operate at the requested depth is verified. Then a meeting with the sponsor (requestor) is planned and scheduled. The purposes of the meeting are to discuss the scope of the task, to relay the support requirements for operation of the system, and to arrange further details concerning the support ship, handling equipment, and fuel access. If the SCAT crew is unfamiliar with the support ship, arrangements are made for a survey to assure that the craft is capable of filling this role.

When the crew is familiar with the support ship and the other on-site support needs are filled, the mode of transporting the system can be selected from among the following choices:

- Commercial airlines
- Overland, by truck
- Military air service (special missions)

Where military air transportation is required, the CURV III Deployment Plans (ref 3) are used. Basically, these deployment plans, decisions, and contacts are applicable to SCAT except that less volume and weight carrying capability are needed. Since this study was conducted to avoid use of the special-missions military air transportation option, this choice is not discussed further.

COMMERCIAL AIR TRANSPORTATION

If the decision to use commercial airlines for transportation has been made, Plan 1 (fig 11) is initiated. The first step is to contact the NOSC Supply Department, Traffic Branch (X7925), and arrange for transporting the four LD-11 (LD-5) containers on board wide-bodied aircraft flights (DC10, L1011, or 747) to the destination airport. Phone numbers for various airline freight offices are listed in appendix B. It is desirable for the crew to fly on the same flight if arrangements can be made.

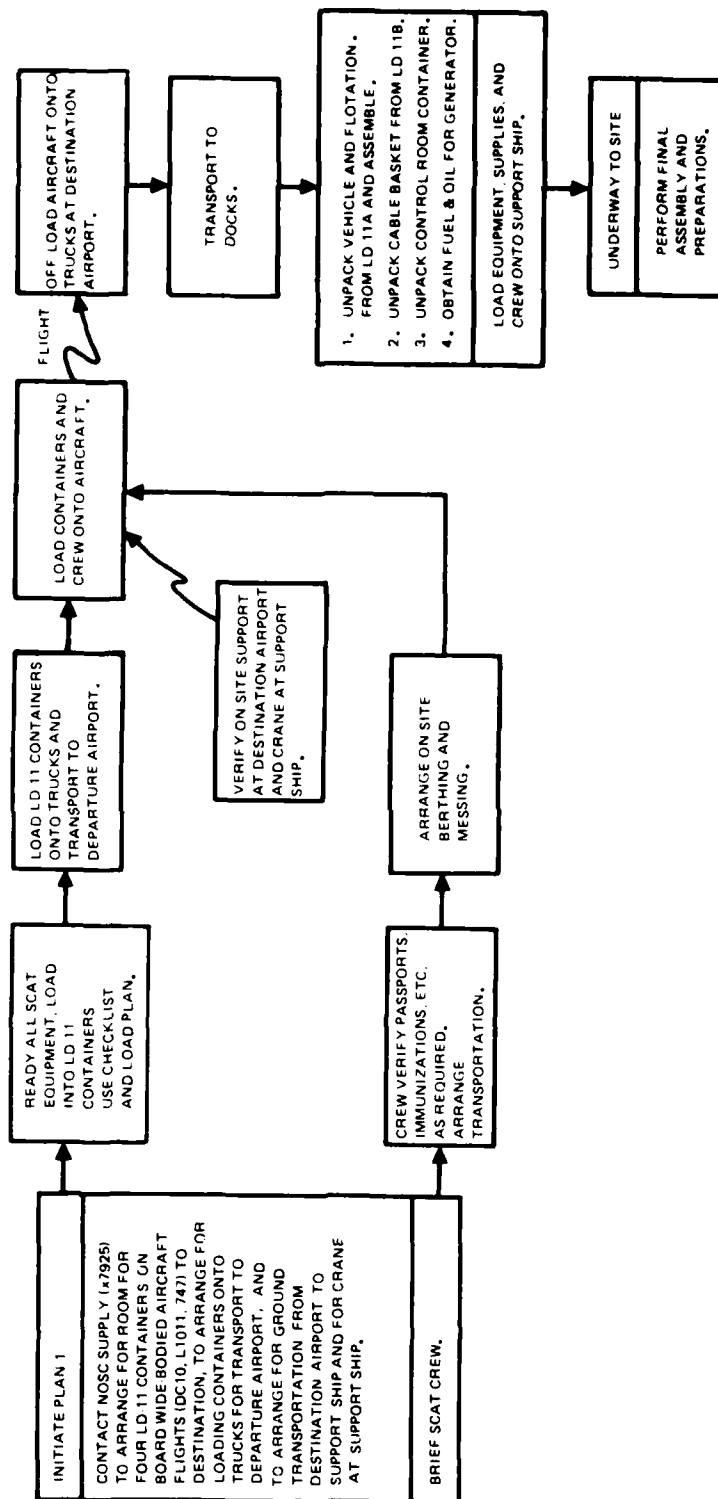


Figure 11. Plan I flowchart commercial air transportation

Arrangements must be made for ground transportation from the destination airport to the ship, necessarily via air suspension trucking to protect the equipment from shock and vibration. Also, it must be verified that a crane and a forklift are available at the ship for unloading the containers.

NOSC Supply Department, Traffic Branch (X7925), should also arrange for loading the containers onto trucks and transporting them to the departure airport (San Diego or Los Angeles). The crew of SCAT should be alerted so that personnel can start getting passports and immunizations as needed and can make arrangements for on-site berthing and messing. The crew is briefed concerning the task so that any special preparations required for the equipment can be performed.

All necessary equipment is readied and loaded into the LD-11 containers according to the packaging plan. The checklist in appendix C is used to verify that the required equipment is loaded. The containers then are loaded onto air suspension trucks and transported to the departure airport, where they and the crew are loaded on board the aircraft. If only three LD-11s are owned, a fourth is obtained and the pop-top control room is loaded into it at the airport. Before leaving, it is advisable to verify the availability of the necessary support at the destination airport and of the crane at the ship.

At the destination airport, the containers are loaded by forklifts onto air suspension trucks and transported to the docks. At the docks, the vehicle and its flotation are unloaded from LD-11A by means of forklifts and are assembled. The cable basket is unloaded from LD-11B, and the generator is relocated inside for balance in hoisting. Necessary fuel and oil for the generator are obtained. The internal pop-top control room container is unloaded from its LD-11. (This could have been done at the airport if an airline-supplied container was used.) All containers and equipment are hoisted by crane and placed in position on the support ship. Departure to the operation site follows verification that the crew, equipment, and supplies are all on board. Final preparations and assembly are performed during transit to the site.

OVERLAND TRANSPORTATION

If the decision is made to use overland transportation, Plan 2 (fig 12) is initiated. The first step is to contact the NOSC Supply Department, Traffic Branch (X7925), to arrange for shipping the containers on trucks equipped with air suspension to protect the equipment from shock and vibration. Forklifts are necessary for loading the equipment onto the trucks and for unloading them at the docks. A crane is necessary on the ship to hoist the equipment from the docks. Arrangements must be made for the crew's transportation, berthing, and messing for the task. The crew is briefed on the task so that any special preparations to the equipment can be performed. All necessary equipment is readied and loaded into the containers according to the packaging plan. In the absence of air transportation, the pop-top control room is not loaded into a certified LD-11 but is shipped directly as a self-contained unit. The checklist, appendix C, is used to verify that the required equipment is loaded. The containers are then loaded onto the air suspension trucks and transported to the docks. Before departing, it is advisable to verify that the necessary support is available at the docks and ship.

At the docks, the containers are unloaded from the trucks by means of a forklift. The vehicle and its flotation are removed from LD-11A and assembled. The cable basket is unloaded from LD-11B, and the generator is relocated inside for balance in hoisting. Necessary fuel and oil for the generator are obtained. The containers and equipment are hoisted by crane and placed in position on the support ship. Departure to the operation site follows verification that the crew, equipment, and supplies are all on board. Final preparations and assembly are performed during transit to the site.

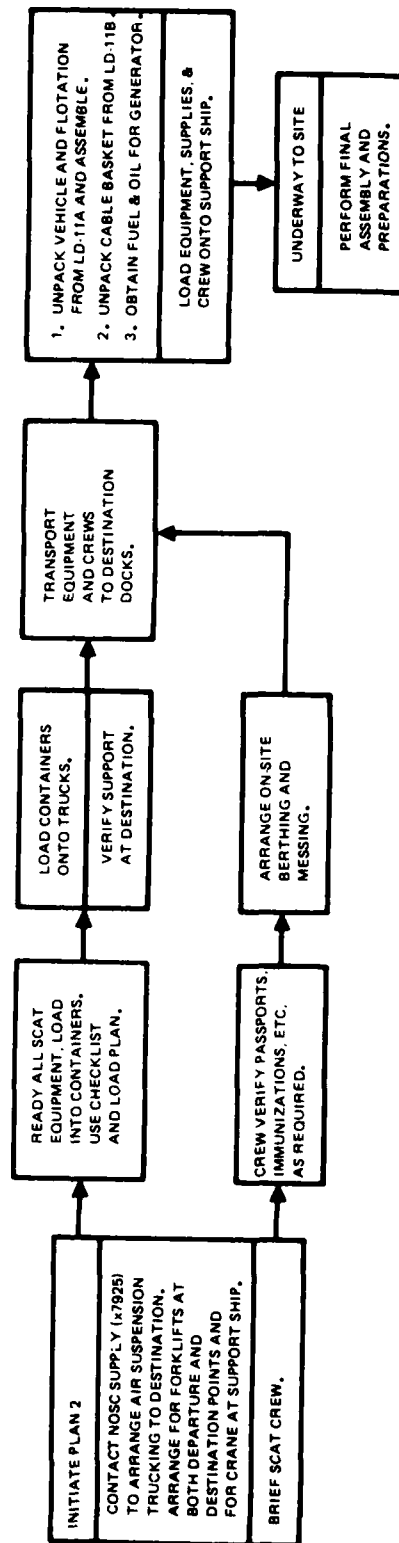


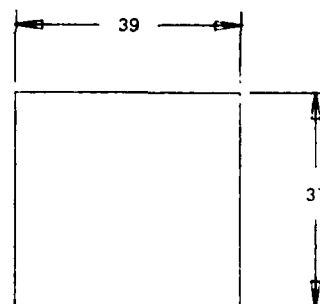
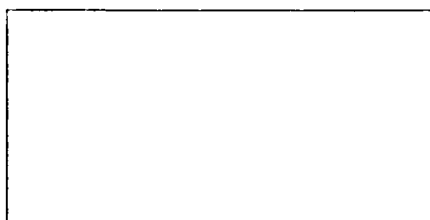
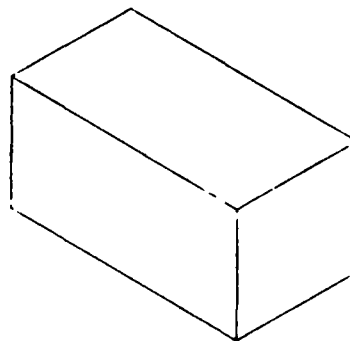
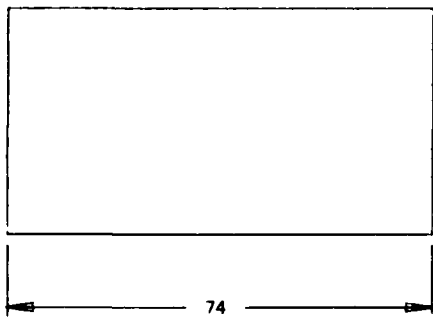
Figure 12. Plan 2 flowchart — overland transportation.

APPENDIX A

COMPONENT SIZES AND WEIGHTS

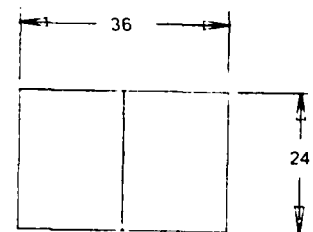
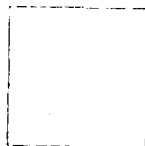
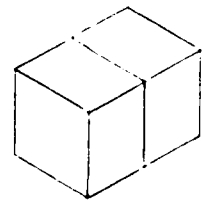
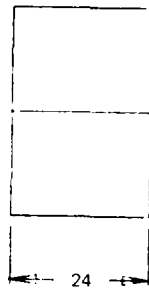
(Dimensions are shown in inches.)

VEHICLE



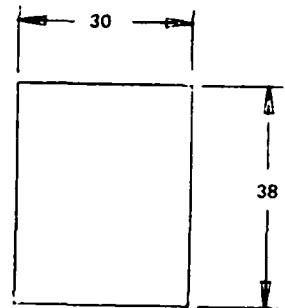
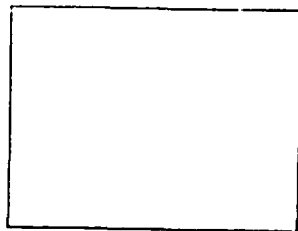
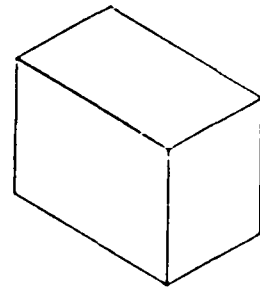
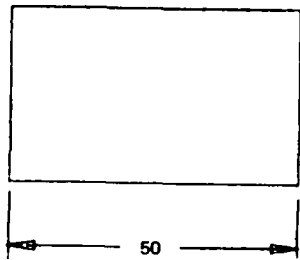
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FLOTATION



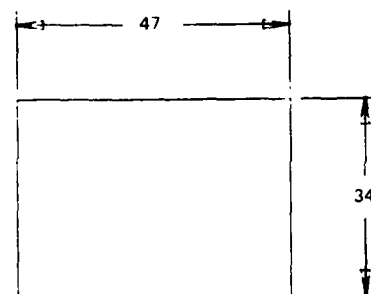
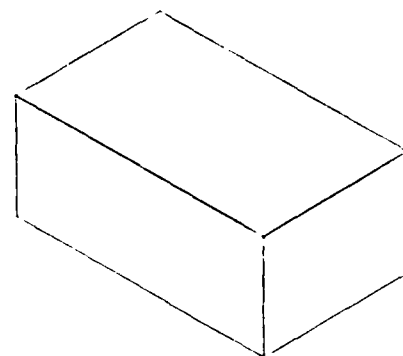
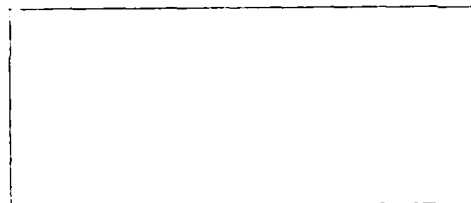
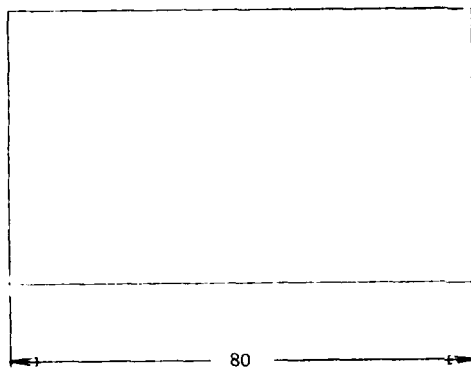
WEIGHT 325 LB

GENERATOR



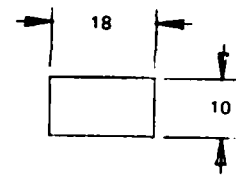
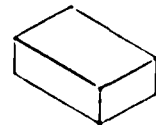
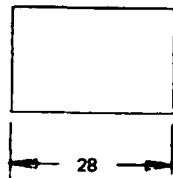
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CABLE



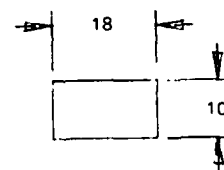
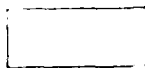
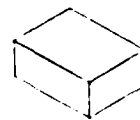
WEIGHT 2700 LB

SONAR DISPLAY



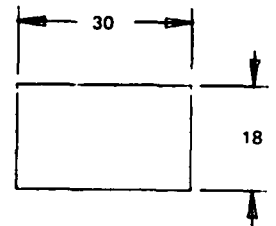
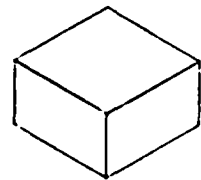
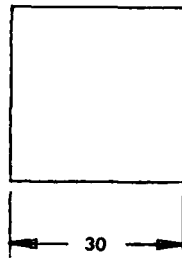
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STEREO TV DISPLAY



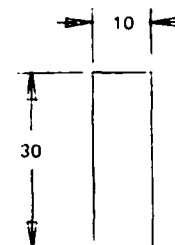
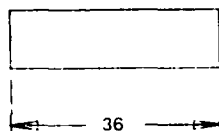
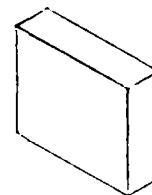
WEIGHT 30 LB

AIR CONDITIONER



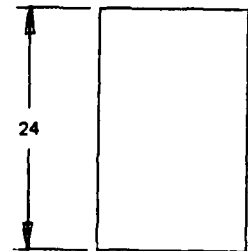
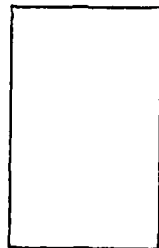
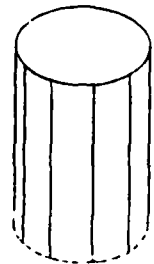
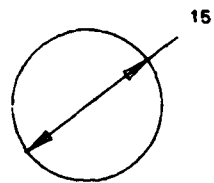
WEIGHT: 66 LB

SWITCH AND RELAY BOX



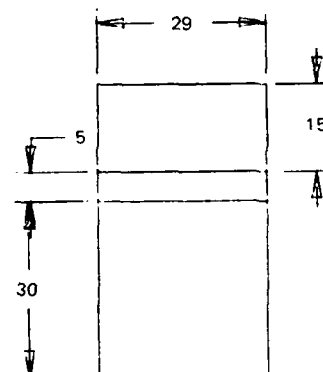
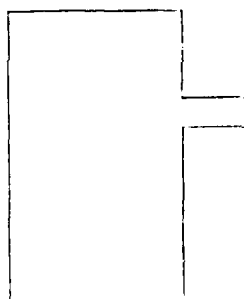
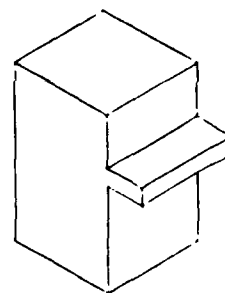
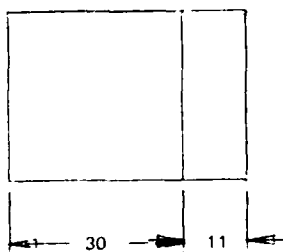
WEIGHT. 75 LB

TRANSFORMERS



WEIGHT: 150 LB

CONTROL CONSOLE



WEIGHT: 125 LB

APPENDIX B

CONTACTS

AIR FREIGHT OFFICES

United Airlines	(619) 231-5600
American Airlines	(619) 231-5400
Western Airlines	(619) 231-5363
Delta Airlines	(619) 231-7611
Trans World Airlines	(619) 231-7329

CONTAINER MANUFACTURERS

Transequip Inc. (213) 603-1996
17923 South Santa Fe St
Compton CA 90220

Brownline and Perkins (213) 539-0320
2950 West Lomita Blvd
Torrance CA 90505

FAA

Manufacturing and Inspection Branch (213) 642-3957

DEPARTMENT OF TRANSPORTATION

(213) 536-6325
(213) 642-5180

APPENDIX C

CHECKLIST OF EQUIPMENT

LD-11A

1. Vehicle
2. Flotation
3. Spare parts and tools $\left(\begin{array}{l} \text{allowable volume: } 129 \text{ cu ft} \\ \text{allowable weight: } 4775 \text{ lb} \end{array} \right)^*$

LD-11B

1. Generator
2. Cable
3. Spare parts and tools $\left(\begin{array}{l} \text{allowable volume: } 96 \text{ cu ft} \\ \text{allowable weight: } 2450 \text{ lb} \end{array} \right)^*$

LD-11C

1. Spare parts and tools $\left(\begin{array}{l} \text{allowable volume: } 203 \text{ cu ft} \\ \text{allowable weight: } 6350 \text{ lb} \end{array} \right)^*$

CONTROL ROOM

1. Sonar display (two)
2. Stereo TV display
3. Air conditioner
4. Switch and relay box
5. Transformers
6. Control console
7. Desk top
8. Folding chairs (two)
9. Light fixture for internal lighting

*Specific lists of spare parts and tools for each container will be established at a later date when more exact requirements are known. Exact allowable volumes and weights can be decided upon only when the actual containers are obtained, since there are variations in the internal dimensions and weights of containers made by different manufacturers.

END

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